

## APPENDIX 3.4-A: NOISE AND VIBRATION MITIGATION GUIDELINES



# **Proposed California High-Speed Train Project Noise and Vibration Mitigation Guidelines**

## **1.0 Purpose**

The California High-Speed Rail Authority (Authority) and Federal Railroad Administration (FRA) conducted a noise and vibration impact analysis consistent with FRA methods for the proposed California High-Speed Train (HST) System. Adverse noise impacts and vibration impacts are anticipated in several areas along the alternatives. To reduce these potential impacts, mitigation measures such as constructing sound barriers or insulating affected buildings could be implemented. To the extent that mitigation measures are feasible and reasonable, they may be applied at the source, along the alignment, or at the receiving building. Criteria for implementing noise mitigation include balancing effectiveness, physical feasibility, cost, and density and proximity of sensitive receptors.

This memorandum presents the Authority's noise and vibration mitigation guidelines and incorporates by reference the guidelines, definitions, and technical manuals recognized by FRA as being consistent with FRA noise and vibration mitigation requirements. The guidelines are subject to revision.

## **2.0 Regulatory Requirements**

The National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) establish a mandate for federal and state agencies to incorporate environmental protection and enhancement measures into their proposed programs and projects. The FRA encourages noise abatement for HST projects where severe noise impacts are identified by using the methods in the FRA guidance manual (FRA 2005). The guidance manual includes noise criteria and guidelines to determine the need for mitigation. Noise criteria are stated in terms of outdoor exposure to project-related noise compared with existing noise levels. The manual defines three levels of impact: (1) No Impact, (2) Moderate Impact, and (3) Severe Impact. Project-related noise in the No Impact range is not likely annoying and is considered acceptable by FRA without mitigation. Moderate Impact means project-related noise would be noticeable and may result in some complaints from affected sites, but that impacts are not considered significant under CEQA and mitigation would not be required. Project-related noise in the Severe Impact range represents the most compelling need for mitigation and indicates a high level of annoyance from project noise at affected sites; these impacts are considered to be significant in the context of NEPA, Section 106 of the National Historic Preservation Act, and CEQA.

## **3.0 Noise Mitigation Guidelines**

In general, feasible and effective noise mitigation is required when severe or significant impacts are identified. Mitigation guidelines for the three impact categories identified by FRA are as follows:

- No Impact: No mitigation required.
- Moderate Impact: Mitigation not required but may be considered at the discretion of the Authority.
- Severe Impact: Consideration of feasible and effective mitigation is required if impacts cannot be avoided. The Authority will take steps to reduce noise substantially through mitigation measures that are reasonable, physically feasible, practical, and cost-effective.

Potential noise impact is assessed and mitigation will be considered for undeveloped lands where sensitive receptors will be if there is substantial physical progress (e.g., laying the building foundation) toward the construction of the property by the time the notice of intent of the project has been issued.

## 3.1 Mitigation of Severe Noise Impacts

The Authority has examined different mitigation measures to avoid, minimize, or mitigate severe noise impacts. If severe noise impacts cannot be avoided through project design changes, then the Authority will take steps to reduce severe noise substantially through mitigation measures that are reasonable, physically feasible, practical, and cost-effective.

The following criteria will be used for evaluating the reasonableness of any particular potential noise barrier as mitigation for severe noise impacts:

- Project noise-related increase over existing noise levels.
- Number of noise sensitive sites affected. Generally, at least 10 sites would have to be affected to justify a sound barrier.
- Sound barriers less than 800 feet long generally should not be considered.
- Barrier heights above 14 feet will not be recommended. Mitigation options for areas that require barriers over 14 feet tall will be studied on a case by case basis.
- Is the cost range for the noise barrier within \$45,000 (2010 dollars) per benefited residence?
- Does a substantial majority of the community approve of implementation?

Section 4(f) and Section 106 properties with severe or moderate noise impacts may require mitigation, may not be subject to these guidelines, and will be evaluated on a case-by-case basis.

### 3.1.1 Substantial Noise Reduction

A sound barrier should be constructed only if it would result in a minimum outdoor noise reduction of 5 decibels (dB).

### 3.1.2 Physically Feasible

Noise mitigation measures must be designed, constructed, installed, or implemented in compliance with structural requirements related to ground conditions, wind loading, seismic risk, safety considerations, accessibility, material maintainability and longevity, and applicable engineering design practices and technology.

Sound barriers are the most common noise mitigation measure. The maximum sound barrier height would be 14 feet for at-grade sections; however, all sound barriers should be designed to be as low as possible to achieve a substantial noise reduction. Berm and berm/wall combinations are the preferred types of sound barriers where space and other environmental constraints permit.

On aerial structures, the maximum sound barrier height would also be 14feet, but barrier material would be limited by engineering weight restrictions for barriers on the structure. Sound barriers on the aerial structure should still be designed to be as low as possible to achieve a substantial noise reduction.

### 3.1.3 Visual Effects

Sound barriers could consist of solid, semitransparent, and transparent materials. Barriers could have visual effects, depending on their location and height. Sound barriers could be treated to reduce visual impacts.

### 3.1.4 Cost-Effectiveness

The cost of any particular sound barrier as mitigation cannot exceed \$45,000 per benefitted building. This cost is determined by dividing the total cost of the mitigation measure by the number of affected noise-sensitive buildings that receive a substantial (i.e., 5-dB or greater) outdoor noise reduction. This calculation will generally limit the use of sound barrier mitigation in rural areas that have few and/or isolated residential buildings. If the density of residential dwellings is insufficient to make a sound barrier cost-effective, then other noise abatement measures, such as sound insulation, will be considered on a case-by-case basis. If sound insulation is identified as an alternative mitigation measure, the treatment must provide a substantial increase in noise reduction (i.e., 5 dB [A-weighted scale] or greater) between the outside to inside noise levels for the interior rooms exposed to HST-related noise. If sound insulation is not possible, feasible, or cost-effective, then the Authority will consider other measures, such as purchasing a noise easement.

### 3.1.5 Reasonable

The above factors will have to be balanced to accomplish a package of noise mitigation measures that are effective but reasonable. Reasonableness implies that good judgment and common sense have been applied during the decision-making process. Reasonableness is determined on the basis of several factors regarding the individual circumstances and the specific needs of affected receivers.

## 4.0 Vibration Mitigation Guidelines

Reactions to vibration impacts depend on the maximum levels for an average repeated train pass-by event. The frequency of events is a consideration in the FRA vibration impacts criteria. The FRA guidance manual provides vibration criteria. The FRA distinguishes between *frequent* and *infrequent* vibration events, defining frequent as more than 70 vibration or train pass-by events per day.

An HST may operate within close proximity to existing freight or passenger rail trains where ground vibration already may be present. In such cases, the impact of new HST service is assessed as follows:

- Infrequently Freight or Passenger Rail Services: Four or fewer freight and/or passenger trains per day; HST impact is assessed using the FRA vibration criteria.
- Moderate Freight or Passenger Rail Services: If up to 12 freight and/or passenger trains per day and FRA impact criteria are already exceeded, then HST is considered to cause no impact if its vibration is 5 dB lower than the existing freight and passenger rail operations. If not, HST impact is assessed using the FRA vibration criteria.
- Heavy Freight or Passenger Rail Services: If HSTs pass by at less than half as often as freight and passenger trains, then no impact exists unless the HST vibration exceeds the vibration levels of the freight and passenger operations.

Where the HST track is closer to vibration sensitive receivers than an existing rail corridor, impact will be assessed if the existing train vibration levels are increased significantly. A significant increase is 3 vibration dB (VdB) or more.

Potential vibration impact is assessed and mitigation will be considered for undeveloped lands where sensitive receptors will be if there is substantial physical progress (e.g., laying the building foundation) toward the construction of the property by the time the notice of intent of the project has been issued.

## 4.1 Vibration Mitigation

Vibration mitigation will be considered whenever the criterion is exceeded as determined by detailed analysis. If found feasible and reasonable, mitigation measures will be included as part of the HST projects.

## 4.2 Vibration Guidelines

To the extent they are feasible and reasonable, vibration mitigation measures may be applied at the source, along the path, or at the receiving building. However, the most effective measures are generally those that are applied at the source.

The Authority will use the following cost-benefit criteria to determine the reasonableness of implementing vibration mitigation:

- The minimum length of track mitigated must be determined from calculations based on the FRA detailed analysis methods.
- The vibration mitigation treatment must provide a minimum of 3-VdB reduction for every impacted receiver to be considered effective.
- The Authority will apply the following formula to determine if the mitigation is cost-effective: Length x cost/foot divided by VdB reduction divided by the number of buildings benefitted. If this dollar amount exceeds \$45,000, the treatment is not considered to be cost-effective.

The cost-benefit criteria are designed to ensure that vibration mitigation is installed in areas where receivers would benefit significantly but not in areas where they would do little or no good.

## 5.0 References Cited

Federal Railroad Administration (FRA). 2005. *High-Speed Ground Transportation Noise and Vibration Impact Assessment*. Final report. October.

Federal Transit Administration (FTA). 2006. *Transit Noise and Vibration Impact Assessment*. FTA-VA-90-1003-06. May.